damaged area, using a live-stream night-vision footage to people on the ground, locating survivors amidst the rubble. Unlike manned helicopters, drones create very little noise and can even be fitted with advanced audio devices to pick up hard-to-hear sounds to help locate survivors.

In conclusion, drones are able to assist in risk assessment, mapping, and planning and in reducing the exposure to danger of the disaster workers. Thus the drones could be considered as an effective tool for future disaster response.

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Rajaji Tiger Reserve: conservation opportunities and challenges

The world-famous Rajaji National Park (RNP; 29°15′–30°31′N, 77°52′–78°22′E) Uttarakhand, India has recently been notified as Rajaji Tiger Reserve (RTR). This Protected Area is now the 48th Tiger Reserve in the country and the second in Uttarakhand. Declaring RNP as a Tiger Reserve is noteworthy because it sustains a wide range of endangered animals in the upper Gangetic plains, especially the Asian elephants and tigers. Besides RTR has a great conservation value, since it is an important part of Terai-arc landscape between the Yamuna and Sharda rivers, which is known as Rajaji–Corbett Tiger Conservation Unit (RCTCU, *c.* 7500 km^2). This Conservation Unit in northwest India is one of the eleven level-I Tiger Conservation Units identified in the Indian subcontinent for the long-term conservation of tigers[1].

Though RNP was established in 1983, final notification for the Park was issued in 2013 because of non-settlement of rights of the local people, which provided a full-fledged legal status to it and strengthened the conservation activities. Further, in 2002, this elephant range was also designated as the 11th Elephant Reserve in the country, naming it the Shivalik Elephant Reserve (*c.* 5405 km^2). In addition to existing core area of 819.54 km^2 of the RNP, now a few portions of Laldhang and Kotdwar forest ranges of the Lansdowne Forest Division (LFD) and Shyampur forest range of the Haridwar Forest Division (HFD), which is 255.63 km^2, have been merged under the RTR area, making it about 1075 km^2 in area. This also includes some portions of Bijni forest of the Gohri forest range of the RNP. The LFD, which has been merged with RTR, is now the tenth forest range of the RTR[2]. All these forests are now the buffer zones of the RTR. On one hand, it would facilitate requisite conservation opportunities, especially in habitat management and conservation of tigers and other wildlife and on the other hand, several conservation challenges would also come forward before the frontline staff of wildlife. Conservation challenges would be more critical in the situation when the RNP is holding about 11 tigers[3].

The population of tigers in the RNP during 2006–2010 was recorded to be stable; in 2006 the tiger abundance was 14 (11–17), whereas in 2010 it was 11 (8–15) (ref. 3). However, their occupancy recorded an increase from 390 km^2 in 2006 to 736 km^2 in 2010. Even in 2000, the estimated number of tigers on the west bank of the Park was only 5–10 animals[4]. A study carried out on the status of tiger and leopard in the RCTCU during 1999–2000 revealed that tigers are not utilizing the west bank of the Ganges, i.e. the southwestern part of the RNP[5]. This study indicated that there could be 6–10 adult tigers in the entire 1500 km^2 habitat block, which includes the forest divisions of Shivalik, Dehradun, Narendranagar and Rajaji–Motichur area of the RNP.

Since the last two decades, the RNP has witnessed a stable population of tigers, though the Park has been considered as a favourable breeding ground for tigers. As LFD and HFD adjoin the RNP, therefore based on landscape level planning a feasible habitat management proposal could be formulated to strengthen tiger movement across the RCTCU. Further, the Rajaji–Corbett wildlife corridor could be restored, which would facilitate the movement of tigers and elephants across the RCTCU. Besides, few other important connecting corridors, namely Motichur–Chilla, Motichur–Gohri, Motichur–Kansrao–Barkot and Rawasan–Sonanadi could also be restored within the newly established Tiger Reserve. The provisions of the Wildlife (Protection) Act, 1972 could be effectively implemented through the participatory approach, which would be helpful in monitoring the movement of tigers in remote areas of the Reserve.

Declaring the National Park as a Tiger Reserve would also ensure effective management and monitoring of tiger population across the entire landscape and in contributing to the country-level assessment. Among the nine forest ranges of the RNP, four remain open to tourists every year for seven months (15 November to 15 June). It is clear from the tourist influx rate that their number has since increased, compared to that during the last 5–6 years. While nearly 19,300 tourists had visited the Chilla forest of the RNP in 2008–2009, their number further risen to nearly 22,450. Successful implementation of the eco-tourism plan would be helpful in reducing the man–animal conflict and would also ensure active participation of the local community in conservation initiatives[6]. While framing the activities under the eco-tourism plan, we can also consider bird-watching as one of the components, since several migratory birds arrive in the RTR during winter, including the ruddy shelduck (*Tadorna ferruginea*), common poachard (*Aythya farina*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), northern shoveler (*Anas clypeata*), bar-headed goose (*Anser indicus*), painted stork (*Mycteria leucocephala*) and black-necked stork (*Ephippiorhynchus asiaticus*)[7].

Providing a natural connectivity for frequent movement of tigers is one of the major challenges, which has to be addressed on a priority basis. The broadening of Haridwar–Dehradun national highway (No. 72; which passes across the RTR) to four lanes could affect the movement of wild animals across the Motichur–Chilla, Motichur–Gohri and Motichur–Kansrao–Barkot wildlife corridors. Keeping in view the importance of biodiversity and animal movement across these corridors, efforts are also being made to facilitate a natural connectivity for the animals to move across

various corridors. Four flyovers are being constructed (each ~0.5 km long) in different animal-crossing areas, which lie within the Motichur–Kansrao and Motichur–Chilla corridors. Before 2000, animals were found utilizing the Chilla–Motichur corridor. However, their movements became restricted thereafter, mainly because of increased vehicular traffic pressure on the national highway, the railway track which exists in the park area and also increasing rate of developmental and anthropogenic activities. Nearly 14,100 vehicles were recorded passing every day across this highway, except for about three hours in the night[8].

Assessment of the Chilla–Motichur wildlife corridor using satellite imageries of 1972, 1990 and 2005 revealed that an area of 17.56 km^2 has been lost during 1972–2005, mainly because of various developmental activities[9]. Another study carried out during 2009–2011, showed that 352 individuals of 39 animal species were killed on the Haridwar–Bijnor and Haridwar–Dehradun national highways and on an ancillary road (Haridwar–Chilla–Rishikesh)[10]. Frequent movements of animals are also being restricted due to the Haridwar–Dehradun railway track, which runs across the RNP; notably traffic pressure of trains is quite high after dusk during which activities of nocturnal animals are also high. Therefore, effective monitoring across the railway track and documentation of animals utilizing the area are needed. Since 1987, 23 elephants have been run over by trains on the Haridwar–Dehradun railway track. Records on mortality of other wild animals include 26 sambar (*Rusa unicolor*), 19 spotted deer (*Axis axis*), three wild boar (*Sus scrofa*), two leopards (*Panthera pardus*), one goral (*Nemorhaedus goral*) and one python (*Python molurus*)[11].

Rehabilitation of Gujjars (a nomadic pastoralist community) from Shyampur and Chiriapur forest of the HFD, Laldhang forest of the LFD and RNP (in ranges where the Gujjars still reside) would be a significant conservation challenge, which needs to be addressed on priority basis. In addition, resettlement of a few villages which are situated across the RTR area, especially in crucial corridor areas, would be a challenge to restore the corridors for tiger movement. If we are able to address this problem, it would definitely mitigate the man–animal conflict.

The RTR is one of the crucial wildlife habitats in the northwestern Shivalik landscape, which also forms the northwestern limit of the range of tigers in the country. However, isolation of large migratory corridors and increasing rate of anthropogenic activities are growing problems threatening their long-term survival. For sustainable management of the tigers in this region, the following recommendations are made: (1) Like in Shyampur, the Chiriapur forest range of HFD should also be merged with the RTR to strengthen conservation approaches. (2) Three to four large underpasses (siphons) should be constructed in the Haridwar–Bijnor national highway at the points where animals are known to cross. They need to be kept clean, since debris and stones are deposited rapidly through annual streams, especially during monsoon. (3) A few small islands situated in the Ganges and riparian corridors should be restored and freed from anthropogenic activities. (4) Gujjars residing in the Shyampur and Chiriapur forest ranges of the HFD need to be rehabilitated to restore the ecosystem. (5) Chilla–Motichur (*c.* 3.5 km long and 1.0 km wide) and Rawasan–Sonanadi (*c.* 10.0 km long and 5.0 km wide) wildlife corridors should be restored on priority basis, avoiding anthropogenic and developmental activities. (6) Collection of river bed material from various annual/torrential rivers spread across the RTR should be controlled and monitored regularly, since most of these river courses are important tiger and elephant dispersal routes. Training of frontline staff of wildlife to address issues related to wildlife management and providing local people with alternate livelihood opportunities would also strengthen the conservation efforts.

Interestingly, the same population of tigers of the RNP also used to move sometimes across the HFD and LFD. Studies carried out by the Wildlife Institute of India indicate that there is a potential to restore tiger population in the reserve[3,4]. Sincere management efforts would be needed to restore the tiger population in the Shivalik Hills and Gangetic Plain landscape, which would enable them to move across the Rajaji–Corbett Tiger Reserve. Future of tigers in India depends on maintaining inviolate core habitats for the breeding tiger populations, habitat connectivity for genetic exchange and protection from poaching of tigers and their prey[12]. The RTR is now experiencing advocacy of development and conservation together. To scientifically address all the conservation issues, would be a challenging task in the near future. It is, however, to be seen in the next few years row the development of the area would help the locals without affecting the conservation.

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